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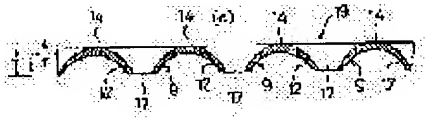
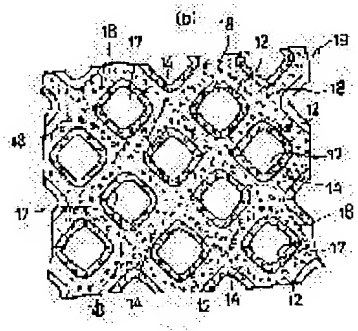
(54) ELECTRODE CORE PLATE FOR BATTERY, MANUFACTURE THEREOF, AND BATTERY

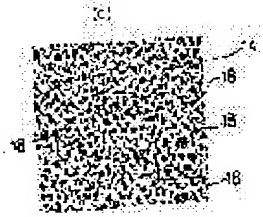
(57)Abstract:

PROBLEM TO BE SOLVED: To provide a core plate with a high active material retaining performance and a high current collecting characteristic and without no fear of generating an internal short-circuit by forming a plurality of through holes and a fine uneven surface by etching, on a conductive metal flat plate having a plurality of projections and curved surfaces which are formed by pressure forming work.

SOLUTION: A thin wall part of a projection 9 is corrosionwise removed by etching of a metal flat plate having a hollow projection and a curved surface which are formed by double-face type pressure forming means comprising a punch and a die, and thereby a fine hole is enlarged and deformed into a through hole 17 and a plurality of fine projective and recessed parts 18 are formed on the curved surface part 14 and an inlined surface part 12. In this way an electrode core plate 19 is provided without a pointed







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part or bur-formed part. With the fine projecting and recessed parts and through holes the bonding force and adhering force to active material are improved. It is preferable that the thickness T of the plate 19 is not more than 3 times that (t) of the original flat plate while the material may be selected from Fe, Cu, Ni, Al, or an alloy mainly composed of any one of them, and the impurities such as Si C or the like should be not more than 0.2 wt.%.

LEGAL STATUS

[Date of request for examination]

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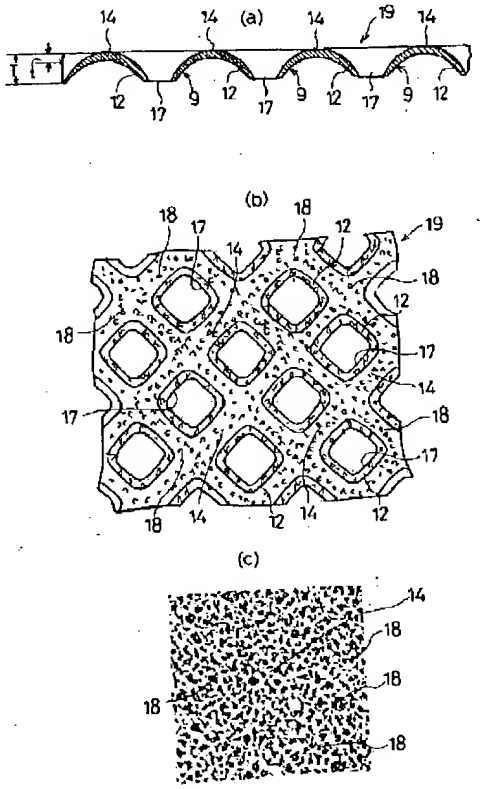
Drawing selection Representative drawing



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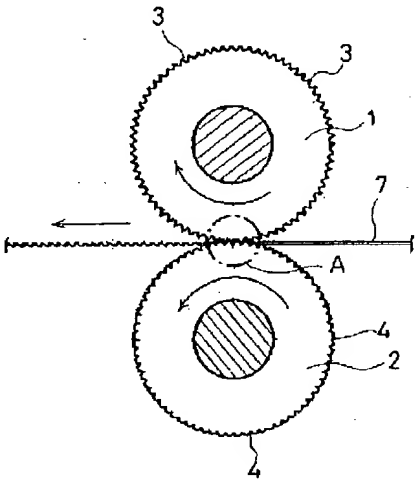
Drawing selection drawing 1



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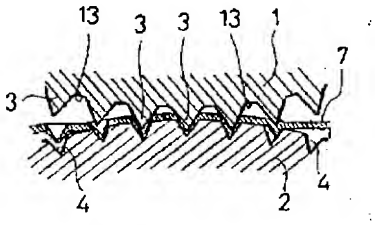
Drawing selection drawing 2



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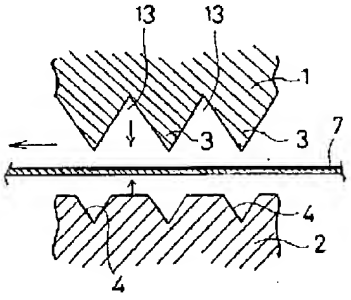
Drawing selection drawing 3

(a)



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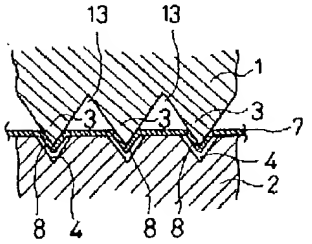

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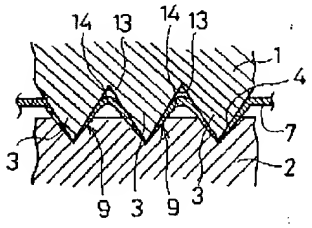

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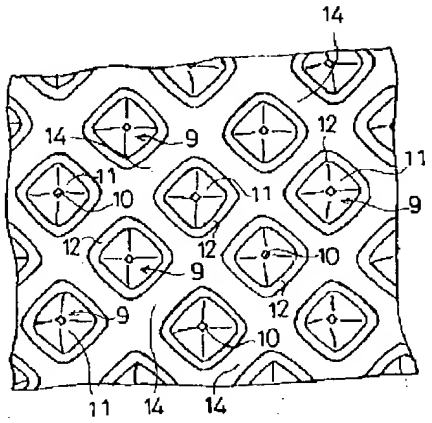
Drawing selection drawing 4



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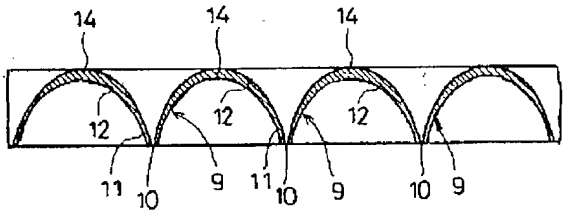
Drawing selection drawing 5



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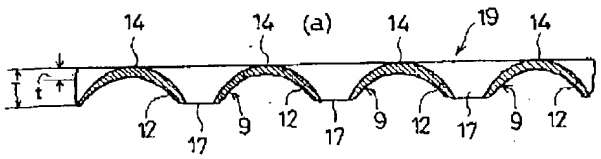
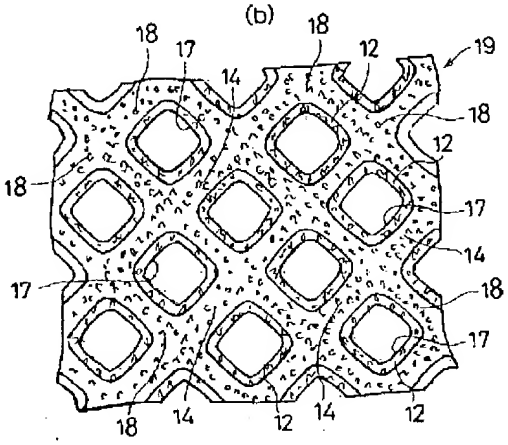
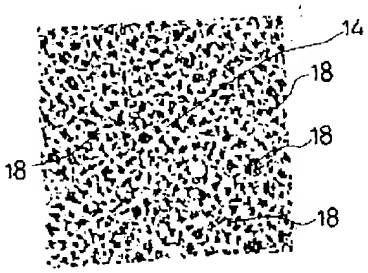
Drawing selection drawing 6







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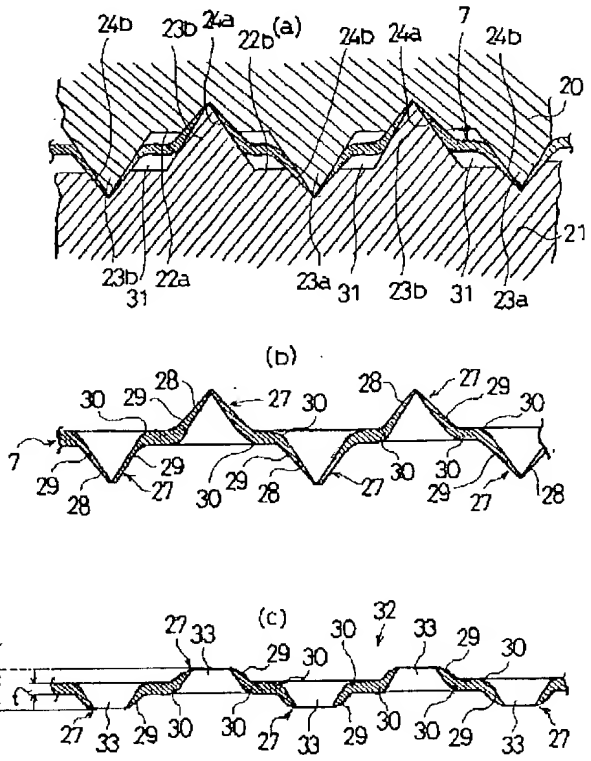
Drawing selection drawing 7



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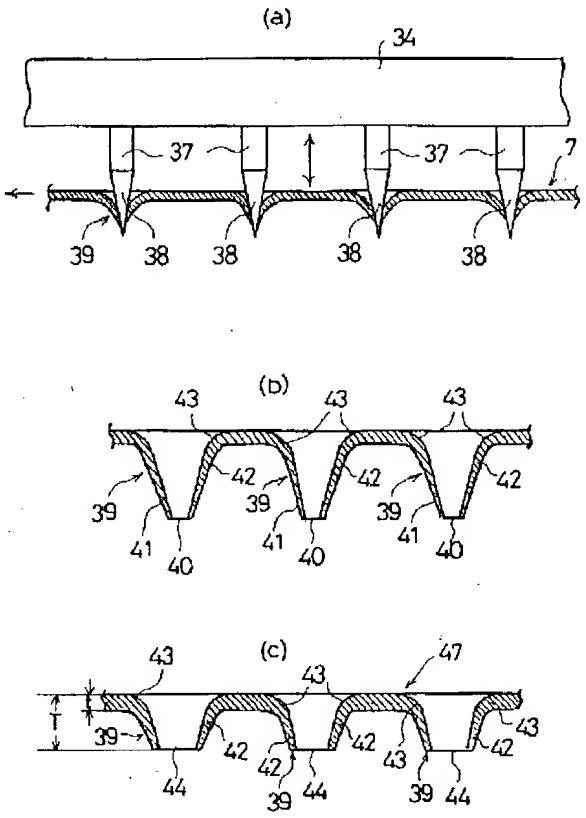
Drawing selection drawing 8



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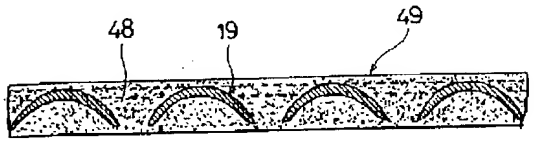
Drawing selection drawing 9



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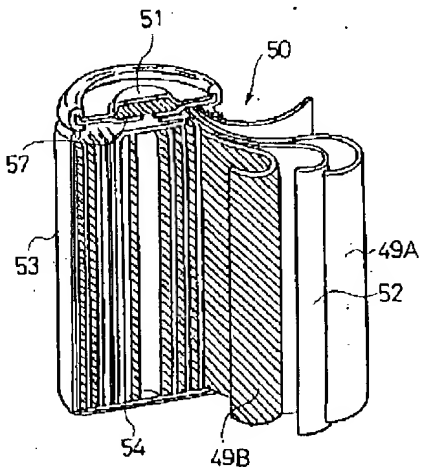
Drawing selection drawing 10



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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the cell using the method of manufacturing positive [which is used for various kinds of primary cells and various kinds of rechargeable batteries mainly represented by a polymer electrolyte rechargeable battery, a nonaqueous lithium secondary battery, the alkali rechargeable battery, etc.], the electrode core plate which is the configuration raw material of a negative electrode board, and it, and said electrode core plate.
[0002]
[Description of the Prior Art] Although a manganese dry battery, an alkali manganese dry battery, and a lithium cell are subjects and the nickel cadmium battery, and nickel and a hydrogen battery have been used abundantly from the former as a rechargeable battery as a primary cell used for the portable device etc., in recent years, the rechargeable lithium-ion battery using the organic electrolysis liquid characterized by the lightweight more thing, the lithium secondary battery using a polymer electrolyte, or the lithium secondary battery using a solid electrolyte is beginning to be used.
[0003] These cells are asked for the engine performance of the formation of high energy density especially in recent years, and it looks forward to the appearance of a cell with high volume energy density (Wh/l) which is index of a miniaturization or lightweight-izing and weight energy density (Wh/kg). Although the active material of the positive electrode which constitutes a generation-of-electrical-energy element, or the negative electrode becomes main as an element which determines the energy density of a cell, the improvement of the electrode core plate which collects a current by holding the active material in an electrode board also serves as an important technical problem. That is, in an electrode core plate, if thin-shape-izing and lightweight-ization can be attained without spoiling reservation of the current collection nature in connection with an electrode reaction utilization factor, and the maintenance capacity of an active material, it will become possible to raise the energy density as a cell.
[0004] As a conventional typical electrode core plate, there are a sintered carrier, the letter metal porous body substrate of foaming, a hair transplantation substrate, a hole aperture wave processing substrate, a punching metal substrate, an expanded metal substrate, a metallic foil substrate, etc. Among these, four sorts of substrate [each], the former sintered carrier, the letter metal porous body substrate of foaming, a hair transplantation substrate, and a hole aperture wave processing substrate, is aimed at the comparatively thick thing from which the thickness of the electrode after processing is set to 0.5mm or more. On the other hand, the thickness of the electrode after processing targets the thin thing relative for three sorts of substrate [each], the latter punching metal substrate, an expanded metal substrate, and a metallic foil substrate.
[0005] A sintered carrier sinters metal powder, such as nickel, in the shape of a substrate, and fills up the hole portion of a sintered compact with an active material, for example, is used for the positive electrode of an alkaline battery etc. Especially this sintered carrier has the advantage excellent in the current collection nature as an electrode board, the maintenance capacity of an active material, etc. The letter

metal porous body substrate of foaming is what used metals, such as nickel, as the sponge-like three-dimensions porous body, and is adopted as the positive electrode of the alkaline battery of high capacity etc. by current. Moreover, a hair transplantation substrate transplants hair in a fibrous metal on the front face of a metal sheet. The hole aperture wave processing substrate was indicated by JP,7-130370,A, JP,7-335208,A, etc., and the improvement of the current collection nature as an electrode, the maintenance capacity of an active material, etc. is expected by fabricating to a wave further, after forming weld flash in the perimeter of the hole punched from one side or both sides of a metal plate, and adopting it as the application type electrode which applies an active material.

[0006] A punching metal substrate performs hole processing to a metal plate by metal mold punch, and an expanded metal substrate carries out lath processing of the metal plate. Since all are comparatively cheap, these substrates are used abundantly as an electrode core material. Since the metallic foil substrate has the feature that it is thin as an electrode core plate, using metallic foils, such as aluminum and Cu, as an electrode core plate, it is used abundantly as a thin object for electrode boards at the lithium secondary battery etc.

[0007]

[Problem(s) to be Solved by the Invention] The maintenance capacity of an active material is [that current collection nature is high to such an electrode core plate,] high, A projection or weld flash of an acute configuration do not exist [a head which generates the internal short circuit between positive / by breaking through a separator /, and a negative electrode], The requirements of the engine performance as electrode boards, like that volume is small for the formation of high energy density and the electrolytic solution and gas can circulate moderately and having high mass production nature cheaply are searched for. However, what satisfies above-mentioned various requirements with sufficient balance does not exist in each above-mentioned electrode core plate.

[0008] That is, since the rate of a volume ratio of a base material is high, the sintered carrier is expensive to a top unsuitable for the formation of high energy density of an electrode board. All of the letter metal porous body substrate of foaming and a hair transplantation substrate are comparatively expensive, and it has the defect which is easy to carry out an internal short circuit with a metaled projection, respectively. Since a hole aperture wave processing substrate holds an active material in a projection or weld flash, its degree of coupling with an active material is comparatively weak, and, moreover, it has the defect which is easy to carry out an internal short circuit in the weld flash of the perimeter of a hole. Since each of punching metal substrates and expanded metal substrates is plane comparatively simple configurations, they is inferior in current collection nature, the maintenance capacity of an active material, etc. Since a hole does not exist fundamentally, a metallic foil substrate has a technical problem in points, such as a circumference of the liquid of the electrolytic solution, and current collection nature as an electrode board or maintenance capacity of an active material.

[0009] Then, the maintenance capacity and current collection nature of an active material are high, and can attain high energy density-ization, and both this inventions aim at offering the cell using an electrode core plate without fear of generating of an internal short circuit, its manufacture method, and said electrode core plate.

[0010]

[Means for Solving the Problem] In a method of manufacturing an electrode core plate for cells which this invention holds an active material and performs a current collection operation in order to attain the above-mentioned object By much punch sections of a cone mold arranged in the 1st die, or multiple coning, and much concave die sections corresponding to said punch section arranged in the 2nd die Many heights of hollow which carries out pressing processing of the thin metal plate which has conductivity, and projects on said metal plate at the whole surface side, With said height, said metal plate in which the 1st process which forms the bay curved-surface section which curves to hard flow by each ****** of each of this height, and much said heights and said bay curved-surface sections were formed chemical etching or by carrying out electrolytic etching While carrying out corrosion clearance of the thin-walled part at a head of each of said height, respectively and forming many breakthroughs, it has the 2nd process which forms the countless detailed irregularity section by corrosion in all front

faces.
[0011] At the 1st process, since an easy process which performs etching processing is adopted as the 2nd process according to a manufacture method of this electrode core plate, if only it only carries out pressing of the height of a hollow configuration by which a thin-walled part is inevitably formed in a point, corrosion clearance of the thin-walled part is carried out at the 2nd process, and a breakthrough is formed certainly. In carrying out hole processing of the thin metal plate by punch tool like before, it is difficult to punch a hole by high-density arrangement, and a numerical aperture also stops to about a maximum of 20%, and, moreover, weld flash tends to generate it. On the other hand, by manufacture method of an electrode core plate of this invention, while forming a breakthrough with about 60% of high numerical aperture and being able to arrange in high density, a part which weld flash etc. is sharp and sharpened by corrosion by etching reagent is lost, and it becomes possible to manufacture an electrode core plate of high quality without fear of generating of an internal short circuit with very cheaply and sufficient mass production nature.
[0012] By manufacture method of other electrode core plates for cells of this invention Much 1st punch section of a cone mold formed in the 1st die by mutual arrangement, or multiple coning, and the 1st die section of concave a large number, By the 2nd punch section of a cone mold corresponding to much 2nd concave die section corresponding to said 1st punch section prepared in the 2nd die, and said 1st die section, or multiple coning Many heights of hollow which carries out pressing processing of the thin metal plate which has conductivity, and projects by turns on said metal plate at the both-sides side, With said height, said metal plate in which the 1st process which forms the bay curved-surface section which curves to hard flow in each ****** of each of this height, and much said heights and said bay curved-surface sections were formed chemical etching or by carrying out electrolytic etching While carrying out corrosion clearance of the thin-walled part at a head of each of said height, respectively and forming many breakthroughs, it has the 2nd process which forms the countless detailed irregularity section by corrosion in all front faces. In addition to the ability to acquire the same effect as an above-mentioned manufacture method by this, an electrode core plate for cells to which a height projects by turns in both-sides side can be manufactured.
[0013] As for the 1st process in the above-mentioned invention, it is possible for the 1st die and 2nd die to form said height and said bay curved-surface section by reciprocating motion using what has been arranged at parallel. Or a metal plate transported with constant speed between the rotating 1st die and the 2nd die is introduced becoming both roller press gestalten and being engaged mutually, and many heights and said heights in the air can form continuously in said metal plate the bay curved-surface section of a large number which curve to hard flow. This becomes possible to mass-produce an electrode core plate of high quality.
[0014] Moreover, in the above-mentioned invention, application-of-pressure processing of the metal plate with which much heights and the bay curved-surface sections were formed after termination of the 2nd process can be carried out from both sides, and said a part of bay curved-surface section can also be processed into a plane. Thereby, volume of an electrode core plate can be made small and high energy density-ization can be attained.
[0015] On the other hand, in a height to which an electrode core plate for cells manufactured by the manufacture method of this invention projects on a conductive metal plate at a whole surface side, a breakthrough punched in the thickness direction of said metal plate in the interior of this height, and each ** of said height, the bay curved-surface section in which a height curved towards hard flow, and the detailed irregularity section of a large number distributed over all front faces are prepared.
[0016] As compared with the flat-surface section, contact nature of this electrode core plate with an active material improves by having the bay curved-surface section, and further, its solution retention of the electrolytic solution improves while degree of coupling of an active material and an electrode core plate improves by much detailed irregularity sections. Furthermore, while direct continuation of between active material particles of both sides of an electrode core plate is carried out by breakthrough and bond strength of an active material improves by it, the electrolytic solution and gas tend to circulate through a breakthrough. Therefore, since both electrode boards using this electrode core plate have current

collection nature and high maintenance capacity of an active material, and perform etching processing and are formed, weld flash and a sharp part melt preferentially, and are extinguished, and generating of an internal short circuit is inhibited.

[0017] Moreover, in a height to which an electrode core plate for cells manufactured by other manufacture methods of this invention projects by turns on a conductive metal plate at both-sides side, a breakthrough punched in the thickness direction of said metal plate in the interior of this height, and radical cadre of each of said height, the bay curved-surface section in which a height curved towards hard flow, and the detailed irregularity section of a large number distributed over all front faces are prepared. Since this electrode core plate has a height on both sides in addition to an effect of a previous electrode core plate, it has the advantage whose maintenance capacity of an active material improves further.

[0018] In the above-mentioned electrode core plate, it is desirable to consider as a configuration over which many breakthroughs are regularly distributed by two-dimensional grid-like arrangement. Maintenance capacity of an active material becomes equal [a rear spring supporter] by this at the whole, and high current collection nature can be obtained.

[0019] Moreover, as for a hole configuration of a breakthrough, circular or considering as a polygon are desirable.

[0020] Moreover, it is desirable that thickness (thickness of appearance containing a height by the side of the whole surface of a metal plate or a height by the side of both sides) of an electrode core plate for cells sets it as 3 or less times of the original thickness of said metal plate. Although it is desirable as a contact condition with an active material when it considers as 3 or more times, tensile strength when processing an electrode board is insufficient, and a piece of an electrode board is generated or it is easy to become the cause of generating an internal short circuit. Furthermore, when thickness of said electrode core plate for cells is made to Xmum and hole density is made into Y %, it is suitable, if it constitutes so that it may be $20<=X<=50$ and may be $Y<=X+10$.

[0021] Moreover, as for a conductive material which constitutes a metal plate, it is desirable to consider as either of the alloys which make a subject one of metals or these metals of Fe, Cu, nickel, and aluminum, and, as for a conductive material which constitutes a metal plate, it is still more desirable that Si which is the impurity element contained in this, and C are restricted to less than [0.2wt%], respectively. Thereby, decline in a utilization factor of an active material etc. can be prevented.

[0022] Moreover, as for a conductive material which constitutes a metal plate, it is desirable that at least the part is united with another material of the metallic material, an inorganic substance, or the organic substance. Thereby, corrosion by the electrolytic solution etc. can be prevented and endurance can be raised.

[0023] Moreover, a cell of this invention was filled up with an active material from both sides of an electrode core plate for cells of this invention, formed an electrode board, and constituted this electrode board as either a positive-electrode board or a negative-electrode board at least. This cell has high current collection nature, and there is little fear of generating of an internal short circuit, and it can attain high energy density-ization.

[0024]

[Embodiment of the Invention] The gestalt of desirable operation of this invention is explained to details, referring to a drawing.

[0025] Drawing 1 is the front view showing the pressing processing equipment which embodied the 1st process in the manufacture method of the electrode core plate concerning the gestalt of operation of the 1st of this invention, and drawing 2 is the expanded sectional view of the A section of drawing 1 . With both the gestalten of this operation, the case where an electrode core plate is continuously manufactured with a rotary press method is illustrated using the 1st die 1 and 2nd die 2 used as a knurling tool gestalt. The punch section 3 of a rectangular-head drill configuration is formed in the peripheral surface of the 1st die 1 by arrangement of the shape of a predetermined grid. On the other hand, much die sections 4 into which the punch section 3 can enter are formed in the peripheral surface of the 2nd die 2 by the arrangement corresponding to the punch section 3. As a metal plate 7 used as the raw material of an

electrode core plate, the metallic thin plate of the shape of a sheet, such as a metallic foil, for example, metal aluminum sheet metal with a thickness of 25 micrometers etc., is used. About the details of the raw material of this metal plate 7, it mentions later. The metal plate 7 is introduced between the 1st die 1 and the 2nd die 2 which rotate in the direction of an arrow head of drawing 1 , and as shown in drawing 2 , pressing processing similar to deep drawing is performed to it. This pressing processing is explained below, referring to drawing 3 (a) - (c).

[0026] Drawing 3 is processing drawing which developed the rotary press section at the flat surface, the (a) shows a condition just before the metal plate 7 is introduced into the engagement portion of both the dice 1 and 2, and (b) shows the condition that the metal plate 7 began to be introduced between the engagement portions of both the dice 1 and 2. As shown in (b), the metal plate 7 is pushed in being bent along with the die section 4 of the 2nd die 2, when depressed by the punch section 3 of the 1st die 1, and the depression 8 of the rectangular-head drill configuration corresponding to the punch section 3 and the die section 4 is formed. In addition, although the punch section 3 and the die section 4 considered as the rectangular-head drill configuration in the gestalt of this operation, they may be the configuration of multiple drills other than a rectangular-head drill, or a cone.

[0027] Drawing 3 (c) shows the portion of the engagement condition which the punch section 3 and the die section 4 in both the dice 1 and 2 approached most. At this time, as shown in the plan of drawing 4 , and the enlarged vertical longitudinal sectional view of drawing 5 , respectively, of much the punch sections 3 and the die sections 4, an appearance is a rectangular-head drill configuration, and the height 9 in the air is formed in the metal plate 7 by grid-like arrangement. generally micropore 10 forms in the head, i.e., the soffit, of a height 9 of this hollow -- having -- the portion near the soffit of a height 9 -- a thin-walled part 11 -- and the inclined plane section 12 is formed in the perimeter of the upper part of a thin-walled part 11, respectively. Furthermore, as the portion between two adjoining heights 9 each is shown in drawing 3 (c), along with the two adjoining punch sections 3 each, it is bid up in the space 13 between each punch section 3 in the 1st die 1, and the bay curved-surface section 14 which curves towards an opposite direction to a height 9 is formed. This appearance is a rectangular-head drill configuration, and corresponding to arrangement of the punch section 3 prepared in the 1st die 1 and 2nd die 2, respectively, and the die section 4, many heights 9 in the air are arranged by the 2-dimensional configuration where it was regularly distributed in the shape of a grid so that it may show clearly in drawing 4 .

[0028] In the 2nd process, etching processing of the metal plate 7 with which much above-mentioned heights 9 and bay curved-surface sections 14 in the air were arranged is carried out. As shown in drawing of longitudinal section of drawing 6 (a), and the plan of this drawing (b), while amplification deformation of the micropore 10 is carried out by that cause at a breakthrough 17 by carrying out corrosion clearance of the thin-walled part 11 in a height 9, as shown in drawing 6 (c) which is the enlarged view of the portion, much detailed irregularity sections 18 are formed in the bay curved-surface section 14 and the inclined plane section 12 of the corrosion by the etching reagent.

[0029] Thereby, the electrode core plate 19 concerning the gestalt of operation of the 1st of this invention is done. While being corroded by the etching reagent and carrying out the thinning of the inclined plane section 12 slightly, the edge section of the hole edge of a breakthrough 17 serves as roundish [wore], and the part which has the configuration where it sharpened keenly over the whole stops in addition, existing in the electrode core plate 19, as etching processing shows to drawing 6 (a). In addition, it is also effective to use how another mechanical means removes only a part for the point of a height 9 beforehand in advance of etching processing. Or after etching processing, application-of-pressure processing is carried out from the upper and lower sides, and it is good also as a plane in a part of bay curved-surface section 14.

[0030] Although the above-mentioned etching processing is performed by chemical etching or electrolytic etching, the desirable etching condition is explained. When the metal plate 7 is aluminum sheet metal of the gestalt of this operation, this etching reagent is made immersed for 2 minutes in ordinary temperature, using 40% of causticity potassium aqueous solution as an etching reagent. Moreover, when the metal plate 7 is copper sheet metal, this etching reagent is made immersed for 12

minutes, using 20% of ferric chloride aqueous solution as an etching reagent. Furthermore, when the metal plate 7 is iron sheet metal, ferric chloride and ten between of nitric acids are made immersed in this etching reagent using the etching reagent mixed at 50% of a rate, respectively.

[0031] Drawing 7 (a) shows drawing of longitudinal section showing the pressing processing equipment which embodied the 1st process in the manufacture method of the electrode core plate concerning the gestalt of operation of the 2nd of this invention. This processing equipment is illustrated using the 1st die 20 and 2nd die 21 used as a knurling tool gestalt as shown by drawing 1 as well as the gestalt of the 1st operation as drawing which developed the case where an electrode core plate was continuously manufactured with a rotary press method, at the flat surface. While much punch section 23a of the rectangular-head drill configuration which projects from basic surface section 22a to a lower part is formed in the peripheral surface of the 1st die 20 by grid-like arrangement, die section 24a dented from basic surface section 22a in the configuration corresponding to the head of punch section 23a is formed in the two adjoining mid-position each of each ** of punch section 23a, respectively. On the other hand, the 2nd die 21 is the configuration which carried out vertical reversal of the 1st die 20. Namely, while much punch section 23b used as the rectangular-head drill configuration where it can project upwards from basic surface section 22b, and can enter into die section 24a of the 1st die 20 is formed in the peripheral surface of the 2nd die 21 by grid-like arrangement Die section 24b used as the rectangular-head drill configuration where the head of punch section 23a of the 1st die 20 can be made to enter each pars intermedia of punch section 23b is cut from basic surface section 22b.

[0032] The metal plate 7 is introduced between the 1st die 20 and the 2nd die 21. pressing processing which was similar to deep drawing with those punch sections 23a and 23b which correspond mutually and die sections 24b and 24a is performed, and it is shown in drawing 7 (b) -- as -- respectively -- an appearance -- a rectangular-head drill configuration -- it is -- and the height 27 in the air -- both-sides side -- alternation -- and it is formed by grid-like arrangement. a part for the point of the height 27 of these hollow -- a thin-walled part 28 -- and the inclined plane section 29 is formed in the perimeter of a thin-walled part 28, respectively. Furthermore, the perimeter portion of each inclined plane section 29 bends in the space 31 between each basic surface sections 22a and 22b of the up-and-down dice 20 and 21, and the bay curved-surface section 30 is formed in it. In addition, by this manufacture method, micropore may be formed at the head of a height 27, or it may not be formed.

[0033] In the 2nd process, etching processing of the metal plate 7 with which much above-mentioned heights 27 and bay curved-surface sections 30 in the air were arranged is carried out. Although it is not illustrating by that cause in the bay curved-surface section 30 and the inclined plane section 29 while a breakthrough 33 is formed by carrying out corrosion clearance of the thin-walled part 28 of a height 27 as shown in drawing of longitudinal section of drawing 7 (c), much detailed irregularity sections are formed of the corrosion by the etching reagent like the gestalt of the 1st operation. Thereby, the electrode core plate 32 of the gestalt of operation of the 2nd of this invention is done. The edge section of the hole edge of a breakthrough 33 serves as roundish [wore] by etching processing, and the part which has the configuration where it sharpened keenly over the whole stops in addition, existing in the electrode core plate 32.

[0034] Drawing 8 (a) shows drawing of longitudinal section showing the pressing processing equipment which embodied the 1st process in the manufacture method of the electrode core plate concerning the gestalt of operation of the 3rd of this invention, with this processing equipment, is replaced with the 1st and the rotary press method of the gestalt of the 2nd operation, and has illustrated the case where an electrode core plate is manufactured with a reciprocating method. The needle pin 37 of the a large number book which have the point 38 of a rectangular head drill configuration have fix by grid-like arrangement in the soffit section, in the direction of an arrow head, when only fixed length be transport and position, only predetermined distance descend, the metal plate 7 force each point 38 of each needle pin 37 to the metal plate 7, and, as for this application of pressure plate 34, press working of sheet metal be perform in the underside of the application of pressure plate 34.

[0035] If the application-of-pressure plate 34 goes up and the point 38 of the needle pin 37 pulls out from the metal plate 7 after it, the next raw section of the metal plate 7 will be transported to the

predetermined location of the lower part of the application-of-pressure plate 34, will be positioned, and will repeat continuously the process which the application-of-pressure plate 34 descends and presses. In addition, to drawing 8 (a), the graphic display of the cradle which supports the metal plate 7 is omitted.
[0036] By passing through the above-mentioned pressing processing, as shown in the metal plate 7 at drawing 8 (b), of said point 38, an appearance is a rectangular-head drill configuration, and the height 39 in the air is formed by grid-like arrangement. the byway hole 40 punctures at the head of the height 39 of these hollow -- having -- the portion near the head -- a thin-walled part 41 -- and the inclined plane section 42 is formed in the perimeter of the upper part of a thin-walled part 41, respectively. Furthermore, the corner R section 43 is formed in the perimeter of the upper part of the inclined plane section 42.
[0037] In the 2nd process, etching processing of the metal plate 7 with which much above-mentioned heights 39 and corner R sections 43 in the air were arranged is carried out. As shown in drawing of longitudinal section of drawing 8 (c), while amplification deformation of the byway hole 40 is carried out and a breakthrough 44 is formed by that cause by carrying out corrosion clearance of the thin-walled part 41 in a height 39 Although not illustrated in all front faces, like the gestalt of the 1st and the 2nd operation, much detailed irregularity sections are formed of the corrosion by the etching reagent, and the electrode core plate 47 by the manufacture method of the gestalt operation of the 3rd of this invention is done. The edge of the hole edge of a breakthrough 44 serves as roundish [wore] by etching processing, and the part which has the configuration where it sharpened keenly on the whole stops existing also in this electrode core plate 47.
[0038] Also in which manufacture method of the gestalt the above 1st thru/or the 3rd implementation, by having adopted etching processing as the 2nd process, at the 1st process If only it only carries out pressing of the heights 9, 27, and 39 of the hollow configuration by which thin-walled parts 11, 28, and 41 are inevitably formed in a point, corrosion clearance of the thin-walled parts 11, 28, and 41 is carried out at the 2nd process, and breakthroughs 17, 33, and 44 are formed certainly. Thereby, by the manufacture method of the electrode core plates 19, 32, and 47 of this invention, while forming breakthroughs 17, 33, and 44 with about 60% of high numerical aperture and being able to arrange in high density, the electrode core plates 19, 32, and 47 of high quality which abolished the part which weld flash etc. is sharp and sharpened by corrosion by the etching reagent can be manufactured with very cheaply and sufficient mass production nature. On the other hand, in carrying out hole processing of the thin metal plate by the punch tool, it is difficult to punch a hole by high-density arrangement, and a numerical aperture also stops to about a maximum of 20%, and, moreover, weld flash tends to generate it.
[0039] Moreover, the electrode core plates 19, 32, and 47 obtained by the manufacture method of this invention Although all will have much detailed irregularity sections 18 on all front faces, and breakthroughs 17, 33, and 44 are formed, and it is common in a point without the part of the configuration where it sharpened keenly and the electrode board and cell using the electrode core plate 19 by the gestalt of the 1st operation are explained below Of course, an effect with the same said of other electrode core plates 32 and 47 can be acquired.
[0040] After producing an electrode board using the above-mentioned electrode core plate 19, the performance evaluation as a cell was surveyed. Below, this point is explained. Drawing 9 is drawing of longitudinal section showing the electrode board 49 which filled up with and constituted the active material 48 from both sides in the electrode core plate 19, and drawing 10 shows the cell 50 which used this electrode board 49 for the positive electrode and the negative electrode, and constituted it. As this cell 50, the example carried out to the rechargeable lithium-ion battery is explained.
[0041] First, the electrode core plate 19 used for this cell 50 is explained. The aluminum explained with the gestalt of the 1st operation as an electrode core plate 19 for positive electrodes was used. What was manufactured by the same method as the case of the aluminum of the gestalt of the 1st operation was used, using metal copper (Cu) with a thickness of 20 micrometers as an electrode core plate 19 for negative electrodes. In addition, in the case of copper, the nitric-acid solution performed etching processing of the 2nd process. When a puncturing size carried out pressing of each electrode core plate

19 made from this aluminum and copper on the metal plate 7 on the occasion of the pressing of the 1st process using the 1st die 1 which has the punch section 3 of 60 degrees of vertical angles with one-side the pyramid which is 1.0mm, respectively, in 0.1-0.5mm of head portions, one-side puncturing of 0.3mm or less was obtained, and this hole density when carrying out pressing was 2% or less. By carrying out etching processing in the 2nd process after that, hole density went up to about 30%. In addition, 30% or less of the hole density after etching is desirable on the reinforcement of the electrode core plate 19.

[0042] The electrode board 49 and the cell 50 were manufactured using the above-mentioned electrode core plate 19. That is, positive-electrode board 49A plastered the electrode core plate 19 made from aluminum with the active material 48 which mixed an electric conduction agent, a fluororesin binder, etc. which consist of LiCoO2 and acetylene black in the shape of a paste, and after it dried and pressurized [press], this was fabricated in the predetermined size by cutting, and it constituted it. In addition, the lead (not shown) was attached in this positive-electrode board 49A so that the positive-electrode terminal 51 of a cell 50 and connection might be attained. The separator 52 used the polyethylene fine porous membrane whose thickness is 27 micrometers. Negative-electrode board 49B plastered the electrode core plate 19 made from copper with the active material 48 which added the styrene butadiene rubber (SBR) binder, the carboxymethyl-cellulose (CMC) thickener, etc. to the spherical graphite, and was made into the shape of a paste, and after it dried and pressurized [press], this was fabricated in the predetermined size by cutting, and it constituted it.

[0043] Next, where it made SEPARETA 52 intervene and positive-electrode board 49A and negative-electrode board 49B are wound around a curled form, it contained with the metallic-sheath can 53, and the electrolytic solution (not shown) was poured in.

[0044] And while connecting the positive-electrode terminal 51 and positive-electrode board 49A which are the cap section of a sealing cell by the aluminum lead piece (not shown), connection between the negative-electrode terminal 54 of the sheathing can 53 and negative-electrode board 49B was made by the nickel lead piece (not shown). What dissolved the 6 fluoride [phosphoric-acid] lithium (LiPF) with a concentration of one mol [/l.] in what blended (ethylene carbonate EC)-diethyl carbonate (DEC) with the rate of 1:3 by the mole ratio as the electrolytic solution was used. This electrolytic solution was poured in in the cell, and by the usual laser obturation, the metallic-sheath can 53 was obturated with the obturation board 57, and it considered as the sealing cell 50. Cell weight is about 18g and this cell 50 has the cell capacity of 620mAh. Now, let this cell 50 be the cell A concerning this invention.

[0045] In order to perform an engine-performance comparison with the cell A of this this invention, Cells B, C, and D were created as a conventional example. It differs from the cell A of this invention in that Cell B is using the metallic foil as an electrode core plate. That is, while using aluminium foil with a thickness of 25 micrometers as an electrode core plate for positive electrodes, positive and a negative electrode board were constituted, using copper foil with a thickness of 20 micrometers as an electrode core plate for negative electrodes.

[0046] It differs from the cell A of this invention in that Cell C is using the punching metal as an electrode core plate. That is, while using the punching metal made from aluminum of 20% of hole density which has the hole of 2mmphi by 30 micrometers in thickness as an electrode core plate for positive electrodes, positive and a negative electrode board consisted of 25 micrometers in thickness as an electrode core plate for negative electrodes, using respectively the copper punching metal of 20% of hole density which has the hole of 2mmphi.

[0047] It differs from the cell A of this invention in that Cell D is using the hole aperture wave processing substrate given in JP,7-130370,A, JP,7-335208,A, etc. for an electrode core plate. Namely, while using the hole aperture wave processing substrate made from aluminum which formed in both sides of a metal plate with a thickness of 50 micrometers the weld flash produced by hole processing by machining as an electrode core plate for positive electrodes, and was fabricated to the wave Positive and a negative electrode board were constituted using the copper hole aperture wave processing substrate which formed in both sides the weld flash produced by hole processing by machining as an electrode core plate for negative electrodes at the core material with a thickness of 35 micrometers, and was

fabricated to the wave. In addition, about the cell configuration of those other than the electrode core plate in Cells B, C, and D, it was presupposed that it is the same as that of Cell A.
[0048] The class of above electrode core plates manufactured four kinds of mutually different cells A, B, C, and D, and carried out comparative evaluation of the actual engine performance as an electrode board in each of those electrode core plates. First, the standard cell property in the initial state in each cell was investigated. Consequently, about charge and discharge voltage and discharge capacity, four kinds of cells A, B, and C and the big difference between D were not found.
[0049] Next, the high-rate-discharge property under low-temperature environment was evaluated. Charge performed constant-voltage constant-current charge (4.2V, max.0.5A, 2 hours) under 20-degree C environment, and discharge set termination voltage to 3.0V by the constant-current discharge in 1CmA (620mA) under 0-degree C low-temperature environment. Consequently, in discharge voltage or the rate of a discharge capacity factor, the difference was accepted between [four kinds of] cells. Especially, at 0 degree C and the rate of a discharge capacity factor to the nominal capacity of 1CmA, as the average, 87% of value was acquired by Cell B 92% by Cell A, and was acquired by Cell D 86% by Cell C 84%, and it was checked that the cell A of this invention has the outstanding high-rate-discharge engine performance under low temperature clearly.
[0050] Here, constitutionally, since only the electrode core plate 19 is only different as compared with three sorts of other cells B, C, and D, the cell A of this invention is considered to be the difference in the current collection nature of the active material 48 held by the electrode core plate 19 for the difference in the above-mentioned low-temperature discharge property. Therefore, it is thought that the electrode core plate 19 of this invention used for Cell A is most excellent in current collection nature. This is because the contact condition with an active material 48 has been improved as compared with a mere plate, the maintenance capacity of an active material 48 and the solution retention of the electrolytic solution improved by the detailed irregularity section 18 further and current collection nature improved with improvement in the maintenance capacity of an active material 48, when the electrode core plate 19 of the cell A of this invention has the bay curved-surface section 14.
[0051] Furthermore, the cycle-life property in the charge and discharge of four kinds of cells A, B, C, and D was investigated. As a test condition, the number of cycles in the event of lowering of 20% of discharge capacity of a repeat and initial capacity being shown for the charge (4.2V, max.0.5A, 2 hours) by constant-voltage constant current and the discharge (0.5CmA, termination voltage 3.0V) by constant current under 20-degree C environment was judged to be the life of the cell. Consequently, Cells B were [510 cycles and Cell D of 480 cycles and Cell C] the lives of 530 cycles except for the part to Cell A being the life of 660 cycles. And by Cell D, abnormalities called an internal short circuit were comparatively accepted in early stages in some cells of these.
[0052] Therefore, it was checked that the cell A of this invention has the engine performance which was clearly excellent also about the cycle-life engine performance. this is imagined to be a thing resulting from that the adhesion and bonding strength of the electrode core plate 19 and an active material 48 were markedly alike, and improved by the detailed irregularity section 18 of a large number formed in the front face of the electrode core plate 19 of etching processing, and the solution retention of the electrolytic solution being good.
[0053] Moreover, the oscillation of a cell and the impact test were performed apart from the above-mentioned trial. Here, while a vibration test performs charge and discharge to four kinds of cells A, B, C, and D which finished the initial charge-and-discharge cycle, it is the trial which continues and gives a mechanical oscillation with a vibration testing machine, and an impact test is a trial which carries out multiple-times drop of the fixed height blank test cell. These trials tend to distinguish whether a cell tend to cause an internal short circuit.
[0054] Every five of this trial were respectively carried out about four kinds of cells A, B, C, and D. Consequently, it is imagined as what brought an inevitable result from using the electrode core plate to which Cells A, B, and C aimed at exfoliation control of an active material, and conductive improvement in the weld flash which has an edge with this acute cell D although abnormalities were not accepted by all and two of five pieces carried out the internal short circuit about Cell D. In this trial, it became clear

that the reliability with few possibilities that an internal short circuit etc. may occur of the cell A using the electrode core plate 19 is high.
[0055] Furthermore, as a result of disassembling four kinds of cells A, B, C, and D in a dried air and observing the condition of an electrode board, the active material 48 is held most firmly at the electrode core plate 19, and Cell A has checked that the maintenance capacity of an active material 48 was very high. This is because bond strength improved [that the bonding strength over an active material 48 improved by existence of the above-mentioned bay curved-surface section 14 and the detailed irregularity section 18, and] by carrying out direct continuation of the particle of the active material 48 of front reverse side both sides of the electrode core plate 19 through a breakthrough 17. On the other hand, it was checked that especially the copper foil as a negative-electrode board changed into the condition of exposing to the whole surface, and the maintenance capacity of an active material was most inferior the electrode using the metallic foil especially in the cell B as an electrode core plate and in it.
[0056] in addition, in order to acquire an above-mentioned effect certainly in Cell A The appearance thickness which contains the heights 9 and 39 by the side of one side in each electrode core plates 19 and 47, respectively as shown in drawing 6 and drawing 8 (c), Namely, as it is desirable that thickness T of the electrode core plates 19 and 47 is 3 or less times of thickness t of the original metal plate 7 and it is shown in drawing 7 (c) on the other hand It is desirable that the appearance thickness containing the height 27 by the side of both sides in the electrode core plate 32, i.e., thickness [of the electrode core plate 32] T, is 3 or less times of thickness t of the original metal plate 7. Although it is desirable in respect of a contact condition with an active material 48 when appearance thickness T is made into 3 or more times, tensile strength runs short in a pressing process, and a piece arises in the done electrode core plates 19, 32, and 47, or it is easy to become the cause of causing an internal short circuit. Therefore, it is proper to set it as a 3 or less above-mentioned times value.
[0057] Moreover, as a conductive material (metal plate 7) which is the configuration raw material of the electrode core plates 19, 32, and 47, although the gestalt of operation explained aluminum and Cu to the example, fundamentally, what is necessary is just either of the alloys which make a subject one metals of Fe, Cu, nickel, and aluminum, or these metals. Furthermore, it is desirable that especially Si and C are the material restricted to less than [0.2wt%], respectively as an impurity element contained in these conductivity material. When these impurity elements increased in number more than 0.2wt%, respectively, it became clear on the cell property that decline in the utilization factor of an active material 48 and lowering of a cycle life were caused.
[0058] Furthermore, the corrosion by the electrolytic solution etc. is prevented, the improvement in the engine performance of being able to raise endurance is obtained, and the conductive material which is the configuration raw material of the electrode core plates 19, 32, and 47 can raise the property as electrode core plates 19, 32, and 47, when at least the part unites with another material chosen from a metallic material, an inorganic substance, and the organic substance. For example, it makes rival different single metal plates and unifies, or plating processing of the front face of the processed metal plate 7 is carried out further, and it unifies. An inorganic substance and the organic substance of especially this metallic material to unify are also effective in addition to the usual metallic material. The property as electrode core plates 19, 32, and 47 is improved, or corrosion etc. is prevented and these unification enables it to give the improvement in the engine performance of raising endurance etc., and a new effect.
[0059] in addition -- although the gestalt of the above-mentioned operation illustrated and explained the case where it applied to a rechargeable lithium-ion battery -- this invention -- in addition -- for example, it can be adapted also for various kinds of rechargeable batteries, such as various kinds of primary cells, such as an alkali manganese dry battery and a lithium primary cell, and a polymer lithium cell, an alkaline battery.
[0060]
[Effect of the Invention] As mentioned above, according to the manufacture method of the electrode core plate for cells of this invention, since the easy process which performs etching processing was adopted as the 2nd process, if only it only carries out pressing of the height of the hollow configuration

by which a thin-walled part is inevitably formed in a point, corrosion clearance of the thin-walled part is carried out at the 2nd process, and a breakthrough is certainly formed at the 1st process. In carrying out hole processing of the thin metal plate by the punch tool like before, it is difficult to punch a hole by high-density arrangement, and a numerical aperture also stops to about a maximum of 20%, and, moreover, weld flash tends to generate it. On the other hand, by the manufacture method of the electrode core plate of this invention, while forming a breakthrough with about 60% of high numerical aperture and being able to arrange in high density, the part which weld flash etc. is sharp and sharpened by corrosion by the etching reagent is lost, and it becomes [manufacturing the electrode core plate of high quality without fear of generating of an internal short circuit with very cheaply and sufficient mass production nature, or] possible.

[0061] Moreover, according to the electrode core plate for cells of this invention, by having the bay curved-surface section, contact nature with an active material improves as compared with the flat-surface section, and the degree of coupling of an active material and the solution retention of the electrolytic solution improve by much detailed irregularity sections further. Furthermore, while direct continuation of between the active material particles of both sides of an electrode core plate is carried out by the breakthrough and the bond strength of an active material improves by it, the electrolytic solution and gas tend to circulate through a breakthrough. Therefore, both the electrode boards and cells using this electrode core plate have current collection nature and the high maintenance capacity of an active material, and since etching processing is performed and it is formed, neither weld flash nor the sharp part exists, and they do not have fear of generating of an internal short circuit.

[Translation done.]